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REPORT ON WATER QUALITY IN SKELETON LAKE

1972



Ontario

Ministry
of the
Environment

The Honourable
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Minister

Everett Biggs,
Deputy Minister

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REPORT OF WATER QUALITY

in

SKELETON LAKE

1972

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and its surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an ever greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried by the Ministry:

1. Evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory.

- 2) research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal.
- 3) evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Skeleton Lake is one of a series dealing with the water quality aspects of the recreational lakes studies in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Skeleton Lake in 1972 to evaluate the present status of the water quality with respect to bacteria, algae and mineral chemistry. Plant nutrient and dissolved oxygen concentrations in the surface and bottom waters were also determined.

The lake is in the District Municipality of Muskoka and lies in the Precambrian Shield with surrounding topography varying from rolling to steeply sloping hills with some rising to 334 meters (1100 feet) above sea level. Generally, the soil cover is shallow and composed of loam and sand glacial till with a moderate amount of stone.

Generally, the majority of Skeleton Lake was within the Ministry of the Environment Criteria for total body contact recreation over the two surveys. The exceptions, inlet Station 9, which indicated a possible pollution source and inlet Stations 25 and 31, which indicated a public health risk, will be investigated further.

The chemical water quality was excellent on Skeleton Lake. The unenriched status of Skeleton Lake was revealed by the excellent water clarity and small amounts of suspended algae.

In order to maintain the excellent water quality of Skeleton Lake, cottagers should ensure that their waste disposal systems do not allow nutrients or bacteria to gain access to the lake.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae

- water quality with depth
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from May 15 to 19 and from August 6 to 10.

Only chemical and biological samples were collected over a three day period from October 3 to 5.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over five consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and on the first, third and fifth days at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Forty-three bacteriological sample sites were established over the whole lake. Chemical samples were collected at nine inlet stations, one outlet station and at one mid-lake station. In addition to these surface samples, chemical and bacteriological samples were taken from the bottom water at the mid-lake station.

Field Tests

The temperature and dissolved oxygen values were measured at the deep water stations with an electronic probe lowered into the lake

and water clarity was measured with a Secchi disc (Figure 1). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denote the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that don't require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is used as a measure of general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

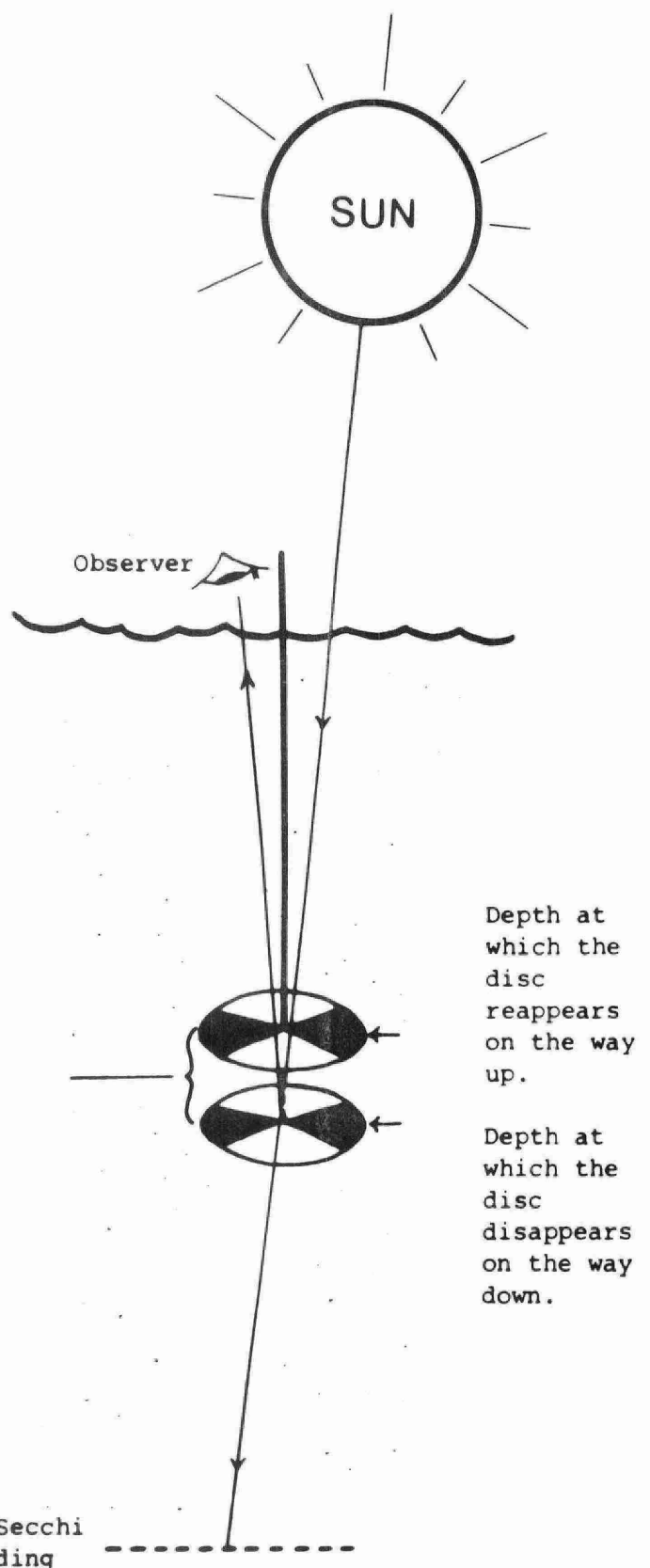
Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Secchi Disc Reading

Clear, algae-free lake:
Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake:
Secchi disc readings tend to be less than 3m (9 feet).

2 times Secchi disc reading



Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen is regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the lighted surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of the illuminated zone as it filled. The sample was then representative of the average number of algae through the depth of the surface waters.

DESCRIPTION OF SKELETON LAKE AREA

Lake and Soil Characteristics

Skeleton Lake is located in the Township of Muskoka Lakes and the Town of Huntsville in the District Municipality of Muskoka.

The lake lies in the Precambrian Shield with surrounding topography varying from rolling to steeply sloping hills with some rising to 334 meters (1100 feet) above sea level. Bedrock surrounding the lake consists of a

Bonded Hornblend Migmatite which is strongly granitized on the west, north and east sides of the lake and moderately granitized on the south side. In many places the bedrock is exposed forming deep cliffs along the south and west shorelines of the lake. These cliff faces range upwards to 22 meters (75 feet). On the northern and eastern slopes the shoreline is much smoother with more soil cover and fewer outcroppings of rock. Generally, the soil cover is shallow and composed of loam and sand glacial till with a moderate amount of stone. Some marshy areas are found in low lying regions.

The lake has a sand and rock bottom that slopes away steeply, much like the surrounding topography. The surface area of the lake is 20 square kilometers (7.5 square miles) which includes a number of small islands situated near the west and south shores. The shoreline length is 38 kilometers (24 miles) while the mean and maximum depths are 30 meters (100 feet) and 66 meters (216 feet) respectively. Skeleton Lake at an elevation of 280 meters (920 feet) above sea level, receives water from underground springs and a watershed that is 58 square kilometers (21.5 square miles) in area. There are numerous small, intermittent inflows but only one outlet. This outlet is the Skeleton River which flows to Rosseau Lake over a wooden control dam operated by the Ministry of Natural Resources. Skeleton Lake forms part of the Muskoka Lakes watershed which is part of the Muskoka River Drainage Basin.

Water Usage

Although there are a few private wells or permanent homes on shore, most cottagers use the lake water as their source of domestic water supply. The lake is mainly used for recreational purposes such as boating, swimming and angling. According to information available from the Ministry of Natural Resources, the common or coarse fish found in Skeleton Lake are white sucker, yellow perch, burbot, rainbow smelt, pumpkinseed, and brown bullhead. Sport fish found in the lake are rainbow trout, brown trout, lake trout, walleye and smallmouth bass.

Shoreline Development

The shoreline of Skeleton Lake is developed to varying degrees. Topographical features makes some areas unsuitable for development. There are approximately 370 cottages on the lake of which 58 are on islands (Figure 2). Included are four resorts with approximately 25 units and three marinas.

RESULTS AND DISCUSSION

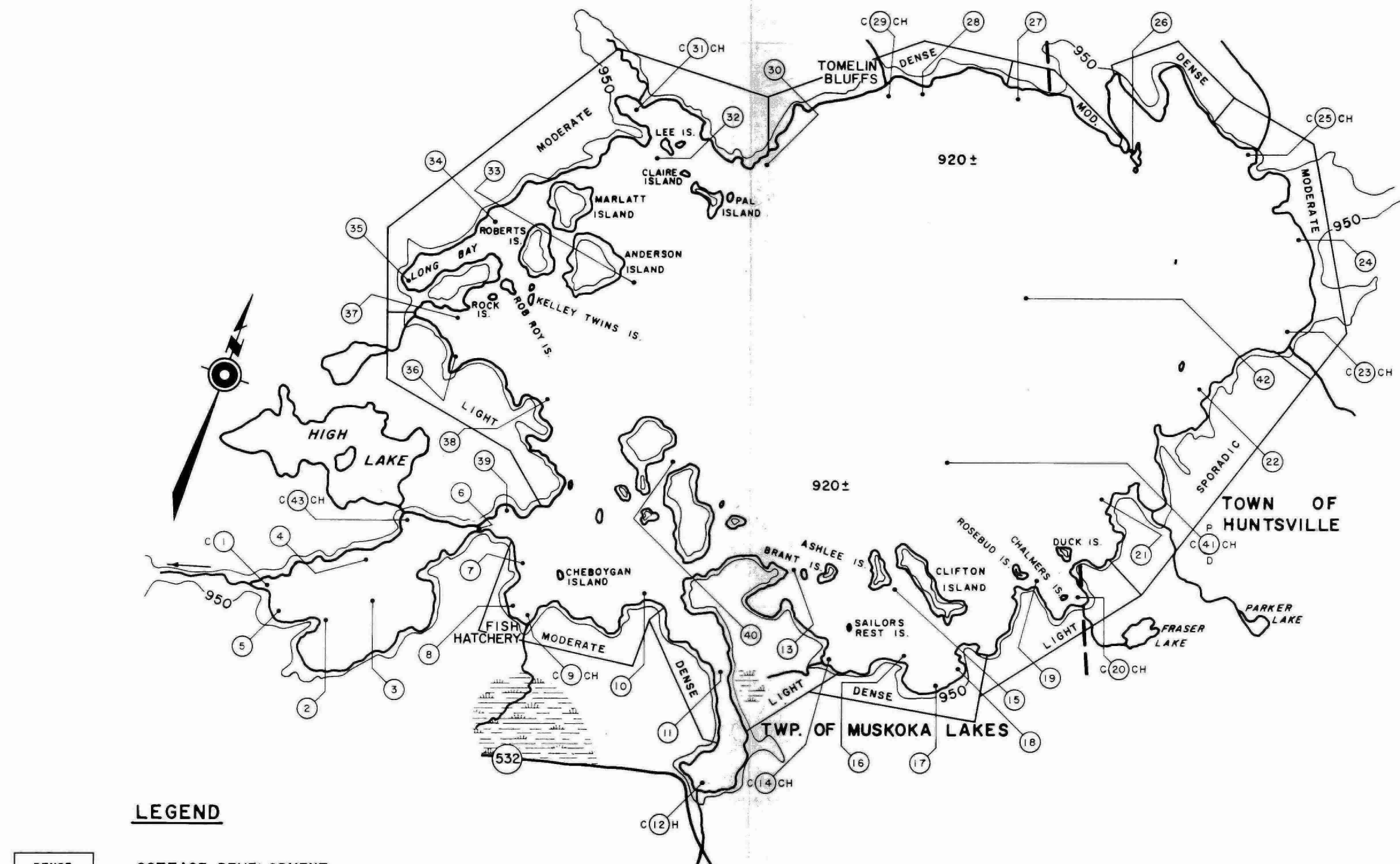
Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

Skeleton Lake generally had very good water quality and was with few exceptions, well within the Ministry of the Environment Criteria for Recreational Use.

In the May survey, the majority of the stations, (Group A) were homogeneous with geometric mean levels of 3 TC, 1 FC and 2 FS/100 ml (Figure 3). The inlet from Fraser Lake (Station 20), the inlet in the southwestern corner of the lake near Cheboygan Island (Station 9), a point on the western shoreline adjacent to Rock Island (Station 37), the area near Lee Island (Group C) and the area at the eastern end of the lake (Group B), displayed mean TC levels of 78, 102, 25, 75, and 53/100 ml respectively which were significantly higher than the overall means. A well cottaged bay in the southern part of the lake, (Station 17) had higher mean bacterial levels of 37 TC and 9 FS/100 ml. and the inlet station (Station 12) along the southern shore also had higher mean bacterial levels of 42 TC, 4 FC and 63 FS/100 ml. Group D adjacent to the Fish Hatchery

FIGURE 2 - COTTAGE DEVELOPMENT AND SAMPLING STATIONS OF SKELETON LAKE



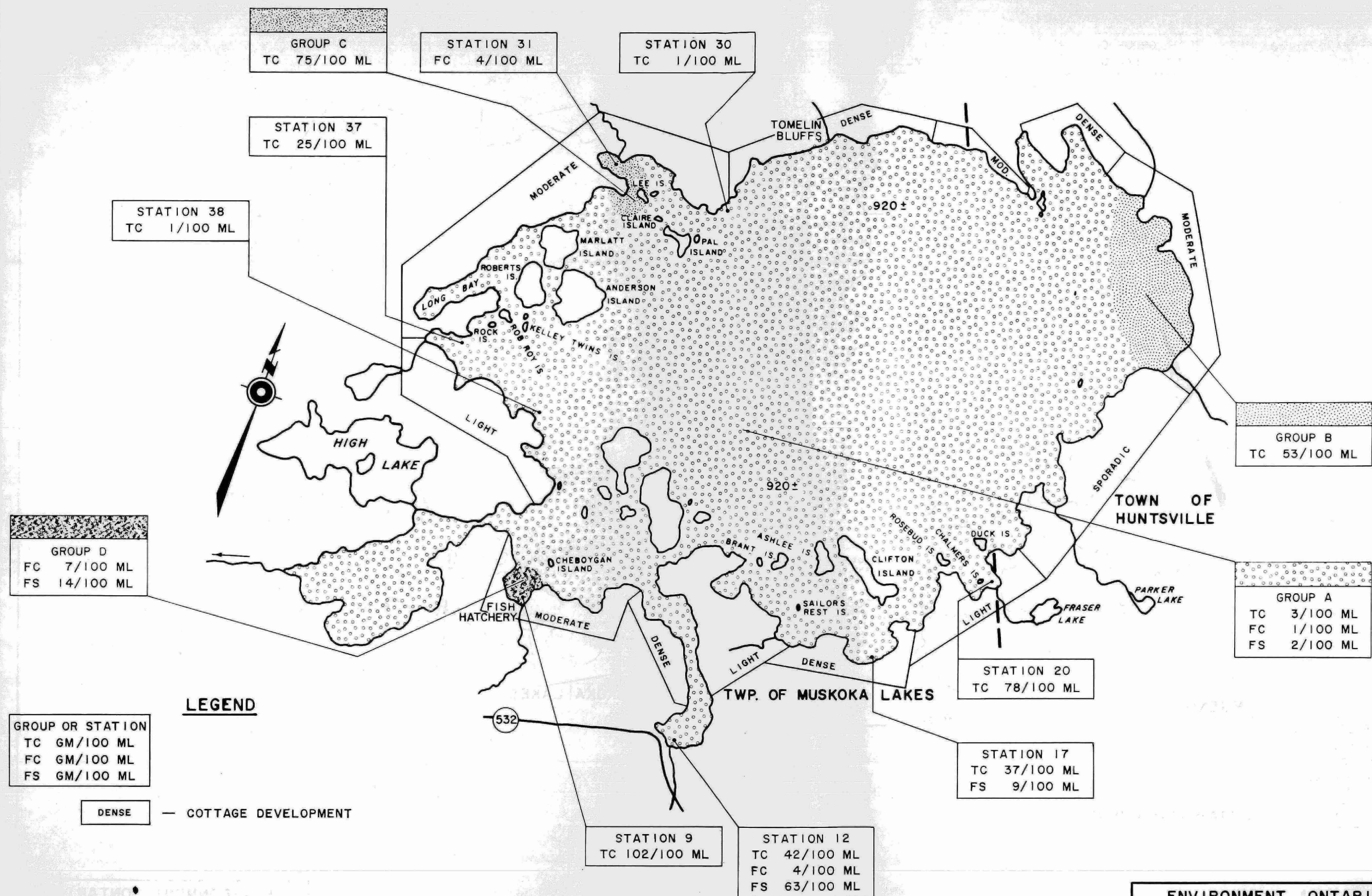
LEGEND

- DENSE — COTTAGE DEVELOPMENT
- 950 — CONTOUR INTERVAL
- MARSH
- P
8
D CH — SAMPLING STATION
 - C — CHEMICAL SAMPLE
 - P — PROFILE
 - CH — CHLOROPHYLL SAMPLE
 - D — DEPTH STATION

0 1/2 MILES

ENVIRONMENT ONTARIO	
RECREATIONAL LAKES PROGRAM	
SKELETON LAKE	
1972 WATER QUALITY SURVEY	
SCALE: AS SHOWN	
DRAWN BY: P. L.	DATE: JAN. 2, 1973
CHECKED BY: R. W.	DRAWING NO: 72-107-DE

FIGURE 3 - DISTRIBUTION OF BACTERIA IN MAY



ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

SKELETON LAKE

1972 WATER QUALITY SURVEY

SCALE: AS SHOWN

DRAWN BY: P. L.

DATE: JAN. 2, 1973

CHECKED BY: R. W.

DRAWING NO: 72-107-DE

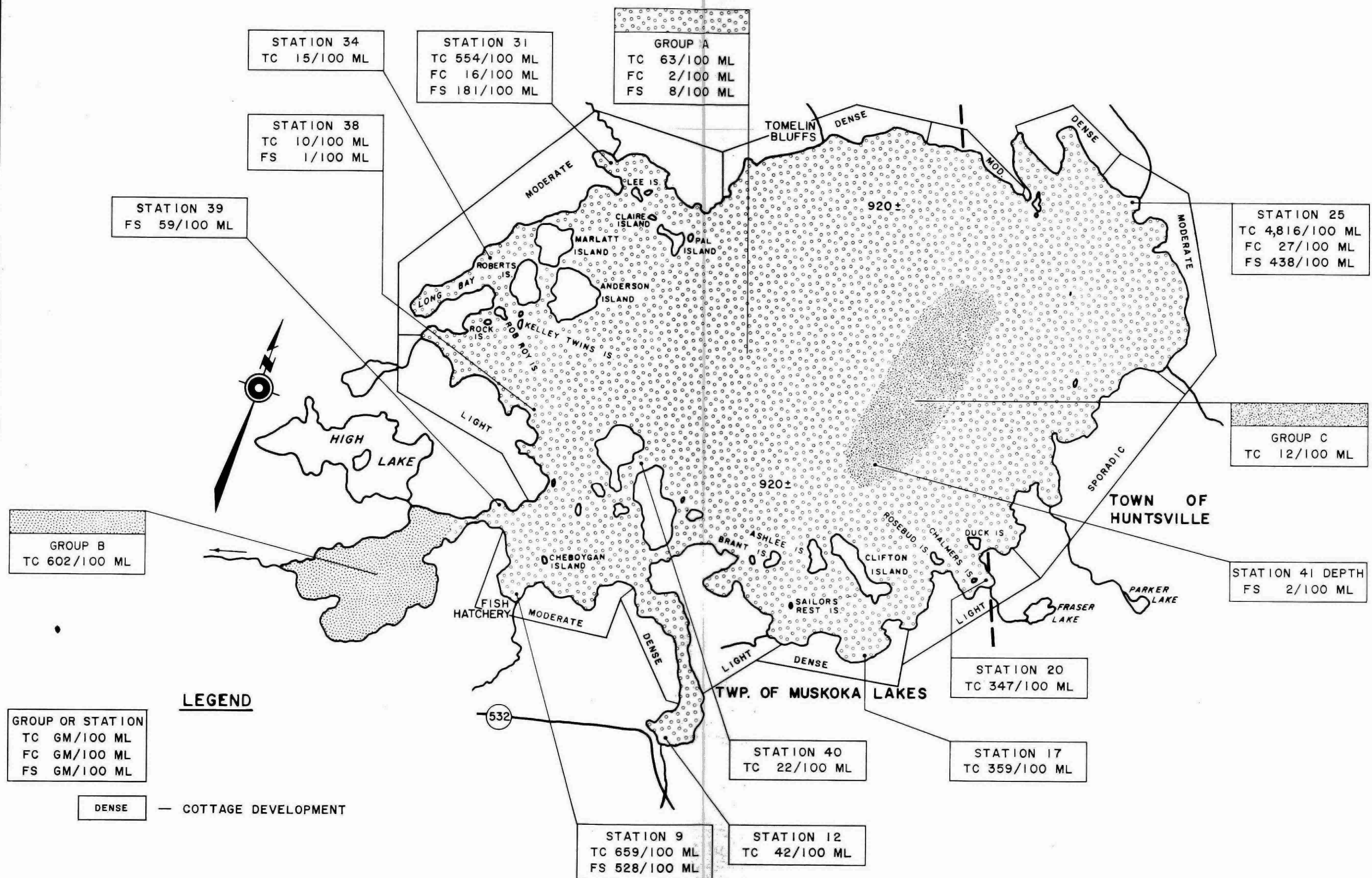
and near Cheboygan Island showed mean bacterial levels of 7 FC and 14 FS/100 ml while Station 31 in the northwestern inlet had 4 FC/100 ml.

Station 38 located on the western shore and Station 30 on the northern shoreline had mean TC levels of 1 TC/100 ml which was significantly lower than the rest of the lake.

In the August survey the majority of stations (Group A) were homogeneous with mean bacterial levels of 63 TC, 2 FC and 8 FS/100 ml (Figure 4). Group B (which includes the bay and the outlet), Station 17 and Station 20 had significantly higher mean TC levels of 602, 359 and 347/100 ml respectively. On the other hand the two mid-lake stations (Group C), Station 40, in the middle of the channel and Station 34 near Roberts Island had significantly lower TC mean levels of 12, 42, 22 and 15/100 ml respectively.

The inlet in the northeastern part of the lake (Station 25) had significantly higher mean bacterial levels of 4816 TC, 27 FC and 438/FS 100 ml, which exceeded both the TC and FS recreational use criteria and indicated the inlet as a source of contamination and public health risk. Station 9 with 659 TC and 528 FS/100 ml and Station 31 with 554 TC, 16 FC and 181 FS/100 ml and Station 39 with 59 FS/100 ml all exceeded the FS criteria. Stations 9, 25 and 31 had higher bacterial levels in both the May and August surveys. Further work will be done to determine the extent and sources of contamination. Mid-lake depth Station 41D had a lower FS level of 2 FS/100 ml. Station 38 again had significantly lower bacterial levels of 10 TC and 1 FS/100 ml.

FIGURE 4 - DISTRIBUTION OF BACTERIA IN AUGUST



ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

SKELETON LAKE

1972 WATER QUALITY SURVEY

SCALE: AS SHOWN

DRAWN BY: P.L.

DATE: JAN. 2, 1973

CHECKED BY: R.W.

DRAWING N°: 72-107-DE

Chemistry

During the May survey, the temperatures and dissolved oxygen values were uniform throughout the water column. For example, on May 15 the temperature was 4°C while the dissolved oxygen was 80% saturation (Figure 5).

By the August survey, a well defined zone of rapid temperature decline was apparent between 7.5 and 11.0 m (Figure 5). Dissolved oxygen concentrations were again at or near saturation. A slight oxygen increase was apparent at about 10 m and was probably due to a production of oxygen by algae suspended in this zone.

By the October survey, the zone of rapid temperature decline had lowered to between 11.0 and 14.0 meters (Figure 5). This lowering is usual for deep inland lakes. The dissolved oxygen concentrations were still at or near saturation at all depths.

Skeleton Lake is a soft water lake having an average hardness value of 14 mg of calcium carbonate per litre. Over the three surveys, conductivity and alkalinity correlated well with slight variations in hardness and along with pH and chloride values, indicate that no unusual mineral characteristics or trends were present in the lake.

Overall means:

Alkalinity	-	6.5 mg/l
Conductivity	-	38 μ mhos/cm ³
pH	-	6.6 units
Chloride	-	1.5 mg/l

Substantially higher concentrations of the above parameters were detected at inflow Stations 9 and 12.

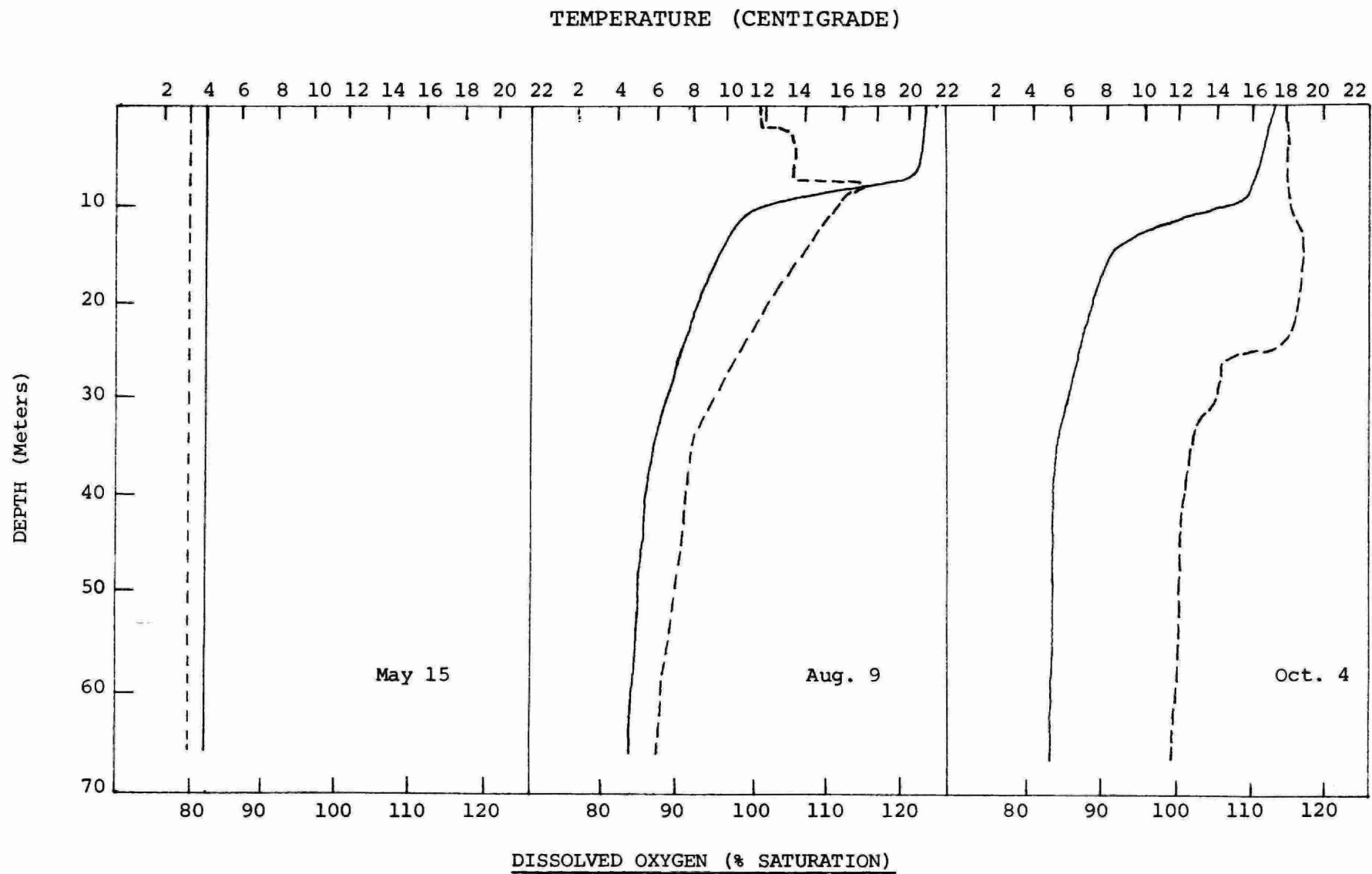


Figure 5 : Dissolved Oxygen (----) and Temperature (——) profiles at Station 41 in Skeleton Lake

Iron values were low at the mid-lake station, averaging 0.06 ppm. Slightly higher concentrations were apparent at most inlet stations.

Phosphorus and Kjeldahl nitrogen values in the surface and bottom waters were extremely low at the mid-lake station throughout the 3 surveys, averaging 0.009 mg P/l and 0.17 mg N/l, respectively. These low concentrations would not cause nuisance growths of aquatic plants and algae. Substantially higher concentrations were noted at inflow stations 9, 12, 17, 18, 25 and 29, but were accompanied by minimal flows.

As can be expected from the low nitrogen and phosphorus mid-lake values, chlorophyll a concentrations were very low, averaging 0.8 µg/l. The mean Secchi disc value of 10.0 meters, indicates the exceptionally good water clarity of Skeleton Lake. A curve relating chlorophyll a and Secchi disc values was derived by Ministry of the Environment staff and illustrates the status of enrichment of Skeleton Lake relative to other well known lakes in Southern Ontario (Figure 6). The unenriched nature of Skeleton Lake is revealed by its proximity on the graph to Lake Joseph and Kenissis Lake, two nutrient poor, clear water lakes.

In order to maintain the excellent water quality of Skeleton Lake, cottagers should ensure that their waste disposal systems do not allow nutrients or bacteria to gain access to the lake.

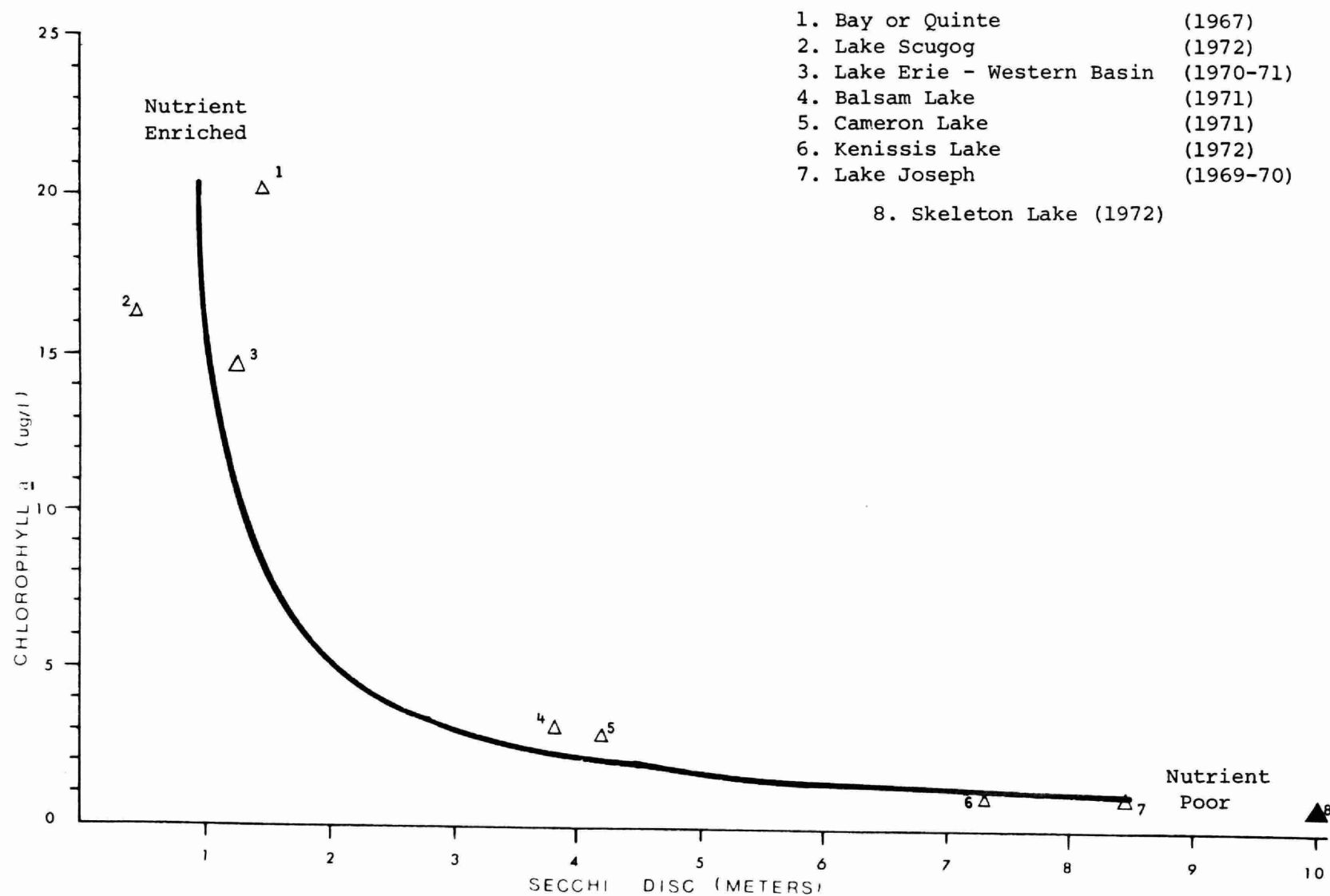


Figure 6 : The mean of chlorophyll a and Secchi disc measurements in Skeleton Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Seven other well known lakes are included for comparison with Skeleton Lake.

INFORMATION OF GENERAL INTEREST TO COTTAGERS MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic

matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomenon^{onw} that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH per 10 ft depth of water		
Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1. 1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

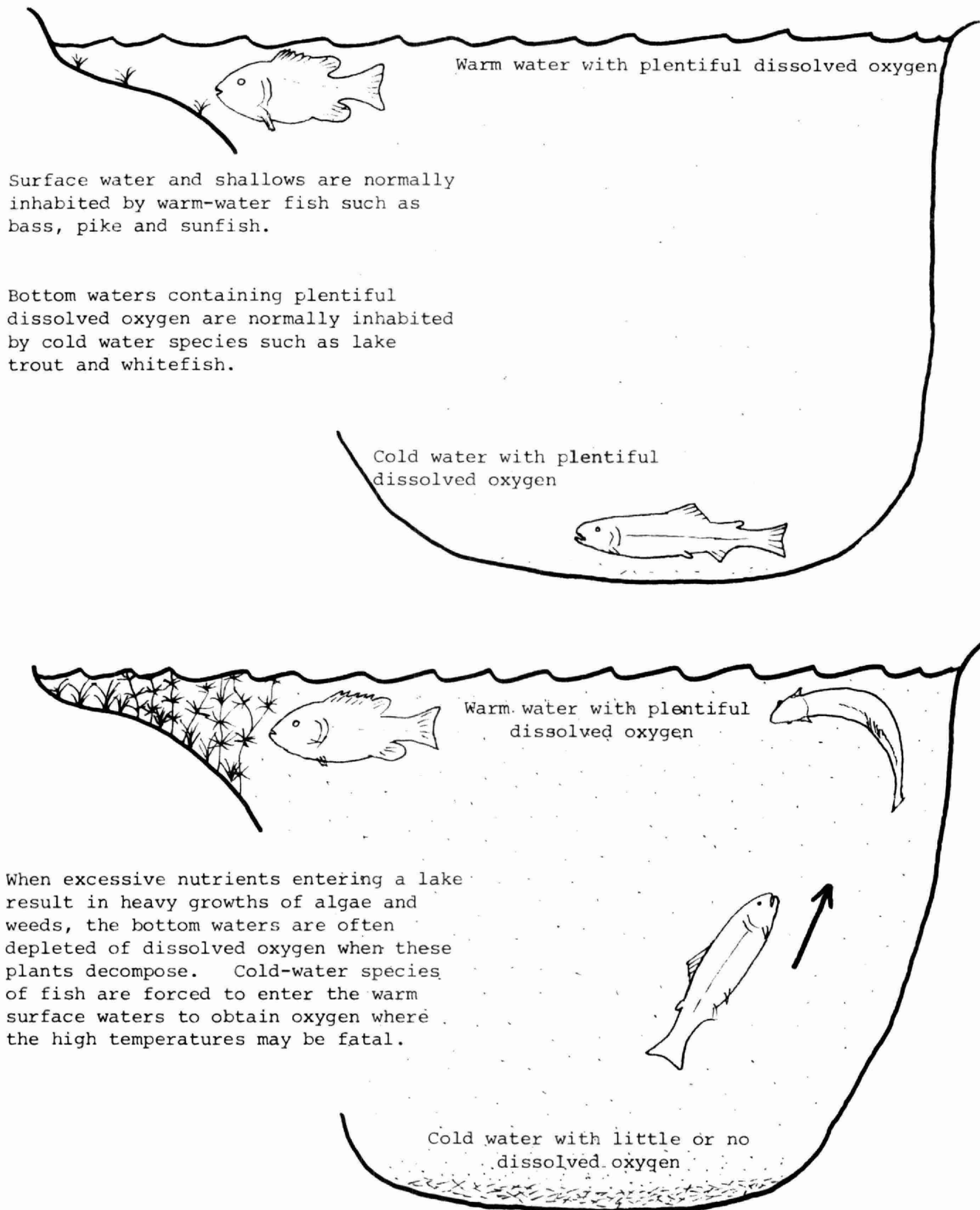
warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with



Surface water and shallows are normally inhabited by warm-water fish such as bass, pike and sunfish.

Bottom waters containing plentiful dissolved oxygen are normally inhabited by cold water species such as lake trout and whitefish.

When excessive nutrients entering a lake result in heavy growths of algae and weeds, the bottom waters are often depleted of dissolved oxygen when these plants decompose. Cold-water species of fish are forced to enter the warm surface waters to obtain oxygen where the high temperatures may be fatal.

FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.